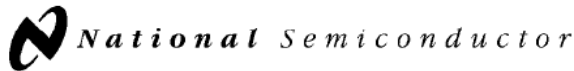


Apéndices

Relación de componentes utilizados:

- 2 Transformadores 120Vac-20Vac a 2 A.
- 1 Interruptor ON/OFF.
- 1 fusible a 1.5 A.
- 2 potenciómetros a 10K Ω .
- 1 optoacoplador 4N429.
- 1 LED.
- 3 Reguladores de voltaje 7805, 7812 y 7912.
- 1 Sensor de temperatura LM35
- 1 Sensor de presión diferencial MPX10D
- 1 Disipador de calor para regulador 7805.
- 1 Transistor TIP 102.
- 1 Amplificador de instrumentación AD524.
- 1 Comparador de voltaje LM311.
- 2 OPAMP entrada JFET TL082 y TL081.
- 6 Resistencias 10K Ω , 1 Resistencia de 330 Ω , 1 Resistencia 5.5K Ω , 1 Resistencia 55K Ω , 1 Resistencia 1K Ω , 1 Resistencia 150 Ω .
- 1 Tarjeta de adquisición de datos NI-6008.
- 1 Resistencia de potencia 13.5 Ω a 10W.
- 2 Puentes de diodos
- 2 Capacitores 1000 μ F.



December 1994

LM35/LM35A/LM35C/LM35CA/LM35D Precision Centigrade Temperature Sensors

General Description

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ\text{C}$ over a full -55 to $+150^\circ\text{C}$ temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only $60\ \mu\text{A}$ from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a -55° to $+150^\circ\text{C}$ temperature range, while the LM35C is rated for a -40° to $+110^\circ\text{C}$ range (-10° with improved accuracy). The LM35 series is

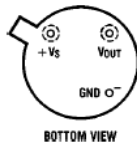
available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-202 package.

Features

- Calibrated directly in ° Celsius (Centigrade)
- Linear $+10.0\ \text{mV}/^\circ\text{C}$ scale factor
- 0.5°C accuracy guaranteeable (at $+25^\circ\text{C}$)
- Rated for full -55° to $+150^\circ\text{C}$ range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than $60\ \mu\text{A}$ current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only $\pm 1/4^\circ\text{C}$ typical
- Low impedance output, $0.1\ \Omega$ for 1 mA load

Connection Diagrams

TO-46
Metal Can Package*

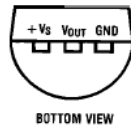


TL/H/5516-1

*Case is connected to negative pin (GND)

Order Number LM35H, LM35AH,
LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

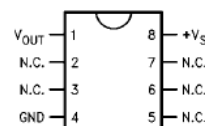
TO-92
Plastic Package



TL/H/5516-2

Order Number LM35CZ,
LM35CAZ or LM35DZ
See NS Package Number Z03A

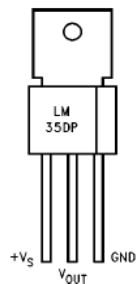
SO-8
Small Outline Molded Package



TL/H/5516-21

Top View
N.C. = No Connection
Order Number LM35DM
See NS Package Number M08A

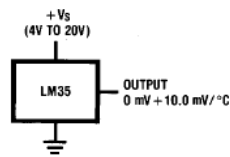
TO-202
Plastic Package



TL/H/5516-24

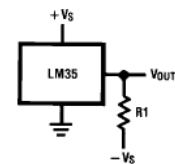
Order Number LM35DP
See NS Package Number P03A

Typical Applications



TL/H/5516-3

FIGURE 1. Basic Centigrade
Temperature
Sensor ($+2^\circ\text{C}$ to $+150^\circ\text{C}$)



TL/H/5516-4

Choose $R_1 = -V_S/50\ \mu\text{A}$
 $V_{OUT} = +1,500\ \text{mV}$ at $+150^\circ\text{C}$
 $= +250\ \text{mV}$ at $+25^\circ\text{C}$
 $= -550\ \text{mV}$ at -55°C
FIGURE 2. Full-Range Centigrade
Temperature Sensor

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AD524

ABSOLUTE MAXIMUM RATINGS¹

Supply Voltage	±18 V
Internal Power Dissipation	450 mW
Input Voltage ²	(Either Input Simultaneously) $ V_{IN} + V_S < 36$ V
Output Short Circuit Duration	Indefinite
Storage Temperature Range	
(R)	-65°C to +125°C
(D, E)	-65°C to +150°C
Operating Temperature Range	
AD524A/B/C	-25°C to +85°C
AD524S	-55°C to +125°C
Lead Temperature (Soldering 60 secs)	+300°C

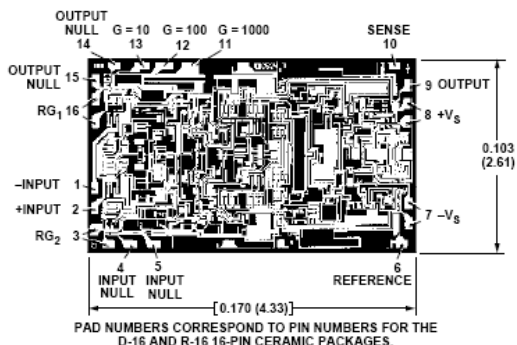
NOTES

¹Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

²Max input voltage specification refers to maximum voltage to which either input terminal may be raised with or without device power applied. For example, with ±18 volt supplies max V_{DC} is ±18 volts, with zero supply voltage max V_{DC} is ±36 volts.

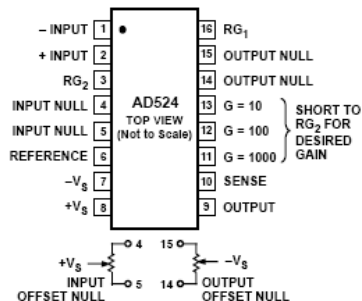
METALIZATION PHOTOGRAPH

Contact factory for latest dimensions.
Dimensions shown in inches and (mm).

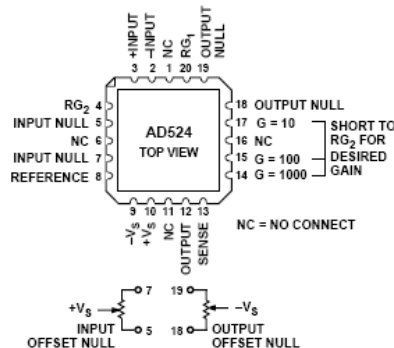


CONNECTION DIAGRAMS

Ceramic (D) and SOIC (R) Packages



Leadless Chip Carrier



ORDERING GUIDE

Model	Temperature Ranges	Package Descriptions	Package Options
AD524AD	-40°C to +85°C	16-Lead Ceramic DIP	D-16
AD524AE	-40°C to +85°C	20-Terminal Leadless Chip Carrier	E-20A
AD524AR-16	-40°C to +85°C	16-Lead Gull-Wing SOIC	R-16
AD524AR-16-REEL	-40°C to +85°C	Tape & Reel Packaging 13"	
AD524AR-16-REEL7	-40°C to +85°C	Tape & Reel Packaging 7"	
AD524BD	-40°C to +85°C	16-Lead Ceramic DIP	D-16
AD524BE	-40°C to +85°C	20-Terminal Leadless Chip Carrier	E-20A
AD524CD	-40°C to +85°C	16-Lead Ceramic DIP	D-16
AD524SD	-55°C to +125°C	16-Lead Ceramic DIP	D-16
AD524SD/883B	-55°C to +125°C	16-Lead Ceramic DIP	D-16
5962-8853901EA*	-55°C to +125°C	16-Lead Ceramic DIP	D-16
AD524SE/883B	-55°C to +125°C	20-Terminal Leadless Chip Carrier	E-20A
AD524SCHIPS	-55°C to +125°C	Die	

*Refer to official DESC drawing for tested specifications.

CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the AD524 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



MOTOROLA
SEMICONDUCTOR TECHNICAL DATA

Order this document
by 4N29/D



6-Pin DIP Optoisolators Darlington Output

The 4N29/A, 4N30, 4N31, 4N32⁽¹⁾ and 4N33⁽¹⁾ devices consist of a gallium arsenide infrared emitting diode optically coupled to a monolithic silicon photodarlington detector.

This series is designed for use in applications requiring high collector output currents at lower input currents.

- Higher Sensitivity to Low Input Drive Current
- Meets or Exceeds All JEDEC Registered Specifications
- *To order devices that are tested and marked per VDE 0884 requirements, the suffix "V" must be included at end of part number. VDE 0884 is a test option.*

Applications

- Low Power Logic Circuits
- Interfacing and coupling systems of different potentials and impedances
- Telecommunications Equipment
- Portable Electronics
- Solid State Relays

MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

Rating	Symbol	Value	Unit
INPUT LED			
Reverse Voltage	V _R	3	Volts
Forward Current — Continuous	I _F	60	mA
LED Power Dissipation @ T _A = 25°C Derate above 25°C	P _D	120 1.41	mW mW/°C
OUTPUT DETECTOR			
Collector–Emitter Voltage	V _{CEO}	30	Volts
Emitter–Collector Voltage	V _{ECO}	5	Volts
Collector–Base Voltage	V _{CBO}	30	Volts
Collector Current — Continuous	I _C	150	mA
Detector Power Dissipation @ T _A = 25°C Derate above 25°C	P _D	150 1.76	mW mW/°C
TOTAL DEVICE			
Isolation Surge Voltage ⁽²⁾ (Peak ac Voltage, 60 Hz, 1 sec Duration)	V _{ISO}	7500	Vac(pk)
Total Device Power Dissipation @ T _A = 25°C Derate above 25°C	P _D	250 2.94	mW mW/°C
Ambient Operating Temperature Range ⁽³⁾	T _A	–55 to +100	°C
Storage Temperature Range ⁽³⁾	T _{stg}	–55 to +150	°C
Soldering Temperature (10 sec, 1/16" from case)	T _L	260	°C

1. Difference in 4N32 and 4N33 is JEDEC Registration for V_{ISO} only. All Motorola 6–Pin devices exceed JEDEC specification and are 7500 Vac(pk). The same applies for 4N29 and 4N30.
2. Isolation surge voltage is an internal device dielectric breakdown rating. For this test, Pins 1 and 2 are common, and Pins 4, 5 and 6 are common.
3. Refer to Quality and Reliability Section in Opto Data Book for information on test conditions.

Preferred devices are Motorola recommended choices for future use and best overall value.
GlobalOptoisolator is a trademark of Motorola, Inc.

REV 4

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4N29
4N29A
4N30*
[CTR = 100% Min]
4N31
[CTR = 50% Min]
4N32*
4N33*
[CTR = 500% Min]
*Motorola Preferred Devices

STYLE 1 PLASTIC

STANDARD THRU HOLE
CASE 730A–04

SCHEMATIC

PIN 1. LED ANODE
2. LED CATHODE
3. N.C.
4. EMITTER
5. COLLECTOR
6. BASE



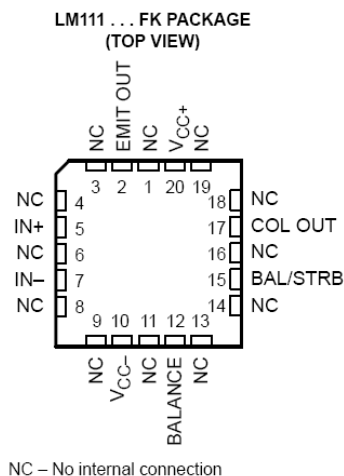
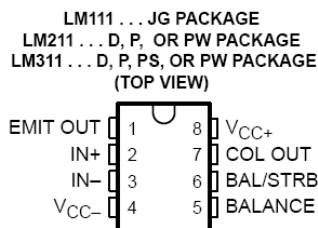
LM111, LM211, LM311 DIFFERENTIAL COMPARATORS WITH STROBES

SLCS007G – SEPTEMBER 1973 – REVISED JULY 2002

- Fast Response Times
- Strobe Capability
- Maximum Input Bias Current . . . 300 nA
- Maximum Input Offset Current . . . 70 nA
- Can Operate From Single 5-V Supply
- Available in Q-Temp Automotive
 - High-Reliability Automotive Applications
 - Configuration Control/Print Support
 - Qualification to Automotive Standards

description/ordering information

The LM111, LM211, and LM311 are single high-speed voltage comparators. These devices are designed to operate from a wide range of power-supply voltages, including ± 15 -V supplies for operational amplifiers and 5-V supplies for logic systems. The output levels are compatible with most TTL and MOS circuits. These comparators are capable of driving lamps or relays and switching voltages up to 50 V at 50 mA. All inputs and outputs can be isolated from system ground. The outputs can drive loads referenced to ground, V_{CC+} or V_{CC-} . Offset balancing and strobe capabilities are available, and the outputs can be wire-OR connected. If the strobe is low, the output is in the off state, regardless of the differential input.



ORDERING INFORMATION

T_A	V_{IO} max AT 25°C	PACKAGE†	ORDERABLE PART NUMBER	TOP-SIDE MARKING	
–0°C to 70°C	7.5 mV	PDIP – P	Tube	LM311P	LM311P
		SOIC – D	Tube	LM311D	LM311
			Tape and reel	LM311DR	
		SOP – PS	Tape and reel	LM311PSR	L311
TSSOP – PW	Tape and reel	LM311PWR	L311		
–40°C to 85°C	3 mV	PDIP – P	Tube	LM211P	LM211P
		SOIC – D	Tube	LM211D	LM211
			Tape and reel	LM211DR	
TSSOP – PW	Tape and reel	LM211PWR	L211		
–40°C to 125°C	3 mV	SOIC – D	Tube	LM211QD	LM211Q
Tape and reel	LM211QDR				
–55°C to 125°C	3 mV	CDIP – JG	Tube	LM111JG	LM111JG
		LCCC – FK	Tube	LM111FK	LM111FK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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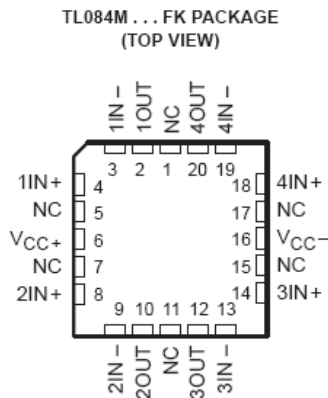
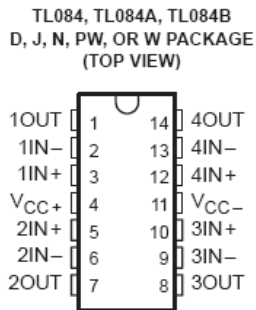
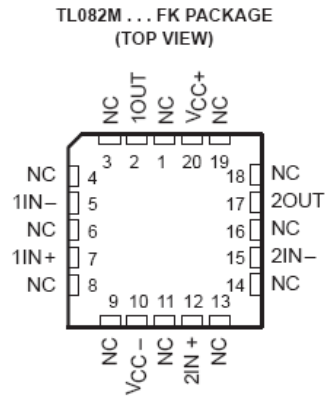
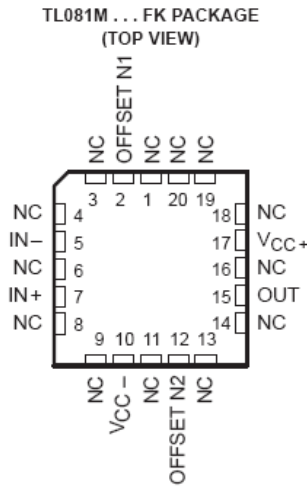
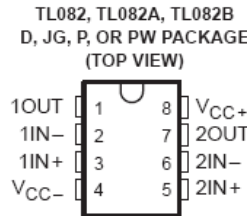
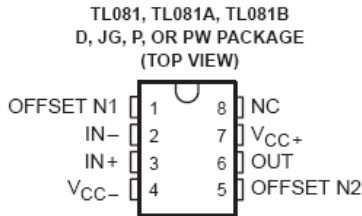
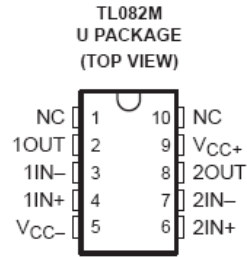
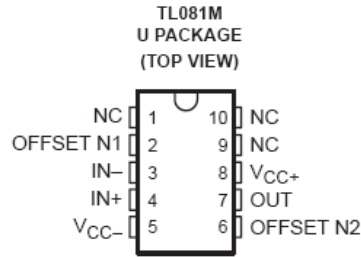
PRODUCTION DATA Information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

TEXAS
INSTRUMENTS

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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

**TL081, TL081A, TL081B, TL082, TL082A, TL082B
TL082Y, TL084, TL084A, TL084B, TL084Y**
JFET-INPUT OPERATIONAL AMPLIFIERS
SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999



NC – No internal connection

**TL081, TL081A, TL081B, TL082, TL082A, TL082B
TL082Y, TL084, TL084A, TL084B, TL084Y
JFET-INPUT OPERATIONAL AMPLIFIERS**
SLOS081E – FEBRUARY 1977 – REVISED FEBRUARY 1999

PARAMETER MEASUREMENT INFORMATION

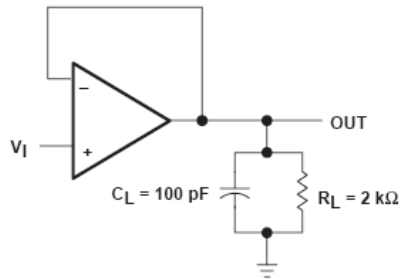


Figure 1

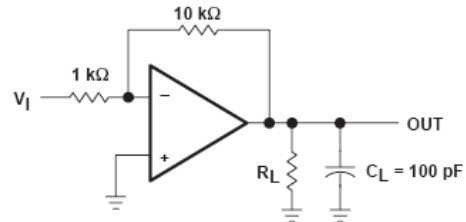


Figure 2

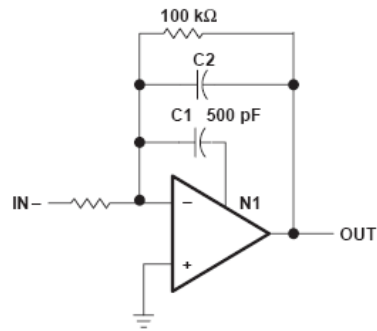


Figure 3

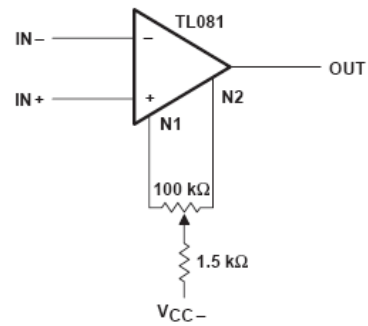


Figure 4

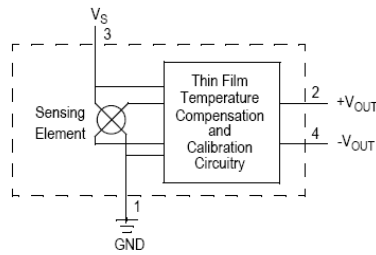


Figure 1. Temperature Compensation Pressure Sensor Schematic

VOLTAGE OUTPUT VS. APPLIED DIFFERENTIAL PRESSURE

The differential voltage output of the sensor is directly proportional to the differential pressure applied.

The absolute sensor has a built-in reference vacuum. The output voltage will decrease as vacuum, relative to ambient, is drawn on the pressure (P1) side.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure

(P1) side relative to the vacuum (P2) side. Similarly, output voltage increases as increasing vacuum is applied to the vacuum (P2) side relative to the pressure (P1) side.

Figure 1 illustrates a block diagram of the internal circuitry on the stand-alone pressure sensor chip.

Table 1. Maximum Ratings⁽¹⁾

Rating	Symbol	Value	Unit
Maximum Pressure (P1 > P2)	P _{MAX}	800	kPa
Storage Temperature	T _{STG}	-40 to +125	°C
Operating Temperature	T _A	-40 to +125	°C

1. Exposure beyond the specified limits may cause permanent damage or degradation to the device.

Table 2. Operating Characteristics ($V_S = 10 V_{DC}$, $T_A = 25^\circ C$ unless otherwise noted, $P_1 > P_2$)

Characteristic	Symbol	Min	Typ	Max	Units	
Differential Pressure Range ⁽¹⁾	P_{OP}	0	—	200	kPa	
Supply Voltage ⁽²⁾	V_S	—	10	16	V_{DC}	
Supply Current	I_O	—	6.0	—	mAdc	
Full Scale Span ⁽³⁾	V_{FSS}	38.5	40	41.5	mV	
Offset ⁽⁴⁾	V_{OFF}	-1.0	—	1.0	mV	
Sensitivity	$\Delta V/\Delta P$	—	0.2	—	mV/kPa	
Linearity ⁽⁵⁾	MPX2200D Series MPX2200A Series	—	-0.25 -1.0	—	0.25 1.0	% V_{FSS}
Pressure Hysteresis ⁽⁵⁾ (0 to 200 kPa)	—	—	± 0.1	—	% V_{FSS}	
Temperature Hysteresis ⁽⁵⁾ (- 40°C to +125°C)	—	—	± 0.5	—	% V_{FSS}	
Temperature Coefficient of Full Scale Span ⁽⁵⁾	TCV_{FSS}	-1.0	—	1.0	% V_{FSS}	
Temperature Coefficient of Offset ⁽⁵⁾	TCV_{OFF}	-1.0	—	1.0	mV	
Input Impedance	Z_{IN}	1300	—	2500	W	
Output Impedance	Z_{OUT}	1400	—	3000	W	
Response Time ⁽⁶⁾ (10% to 90%)	t_R	—	1.0	—	ms	
Warm-Up Time	—	—	20	—	ms	
Offset Stability ⁽⁷⁾	—	—	± 0.5	—	% V_{FSS}	

1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self-heating.
3. Full Scale Span (V_{FSS}) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum related pressure.
4. Offset (V_{OFF}) is defined as the output voltage at the minimum rated pressure.
5. Accuracy (error budget) consists of the following:
 - Linearity: Output deviation from a straight line relationship with pressure, using end point method, over the specified pressure range.
 - Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
 - Pressure Hysteresis: Output deviation at any pressure with the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure at 25°C.
 - TcSpan: Output deviation at full rated pressure over the temperature range of 0 to 85°C, relative to 25°C.
 - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to 85°C, relative to 25°C.
6. Response Time is defined as the time from the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
7. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

